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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

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Forthcoming Events.

Institution of British Foundrymen.

East Midland Branch.—"Foundry Facings," by H. Winterton, on January 28, 1922, at Loughborough.

Coventry Branch.—"Foundry Training," by T. Vickers, on January 11, 1922.

The Standardisation of Pig Iron.

The extreme difficulties underlying the manufacture of grey-iron castings were revealed by Mr. H. J. Young in a Paper recently presented to the Institution of Marine Engineers, the first portion of which is reproduced in this issue. The importance of this contribution to the metallurgy of cast iron cannot be exaggerated, for until Mr. Young's figures are disproved or means found for the standardisation of castings from a non-standardised material, chaos must reign in the foundry and in those trades dependent on it. The lecturer gave figures proving that published analyses of pig-irons do not represent the material they describe. Average figures for a consignment of any one brand will not be applicable to the next, and finally the composition of any one particular stack will vary almost as much as a bin of scrap iron. On the surface this means that the only method of producing a definite mixture is to analyse and weigh each pig or piece of scrap, for it is shown in the course of the Paper this week that the position of at least some forms of the most important castings is analogous to that of the pig-iron trade. Obviously, such a method is far too expensive, and we doubt if it has been used for the production of the closely-agreeing results outlined in Table IV. on page , The question raised is of such importance that the method used to obtain such results should be available to the trade. It is apparent that Mr. Young has been able to carry out an enormous amount of experimental work, and perhaps it is asking too much that the results should be divulged to the world at large, but a communication to the B.C.I.R.A. would make it available for progressive British foundrymen.

Much emphasis is laid on the necessity of controlling the sulphur-manganese ratio. A table is given, which clearly demonstrates that so far as transverse stress is concerned, sulphur is harmless when associated with a suitable manganese content. Speaking of the figures he gives to emphasise this fact, Mr. Young points out that the nearer the critical point of equilibrium between the sulphur and manganese, the more difficult does it become to detect by chemical analysis any difference between two irons—but the two irons remain either very good or very bad right up to each side of the equilibrium. How many foundrymen have realised that such an equilibrium exists and are there other delicate equilibria similarly affecting the properties of cast iron? The researches of Prof. Osann, with which we recently dealt, seem to indicate that one can associate hard white internal regions in cast iron with a low carbon content. This low limit must be ascertained, as must many other similar problems be resolved. The condition of the cast-iron industry must be so metamorphosed that the small founder must be in a position to know his raw materials. If Mr. Young's figures are at all representative of the industry, then mixing by eye is just as likely to get standard results as by mixing by analysis, unless the foundryman has hit upon the lecturer's unrevealed method.

It is usual about this time to formulate resolutions for the New Year, and for foundrymen and users of cast iron there exists nothing better than to resolve to support British cast-iron research by every means within their power, for the problem is so immense that it can only be solved adequately for the general industry by co-operative means. It should be pointed out that even where definite data becomes available on the subject of cast iron, such data will be only of academic interest unless this basic problem of the standardisation of raw material is resolved.

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Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Foundry Costs.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Your report of a "Discussion on Foundry Costs and Establishment Charges" (page 470) shows that the necessity for efficient costing is appreciated by foundrymen generally. I am afraid, however, that the inclusion of material into the question of "on-cost" is likely to cause trouble owing to complicated costing records. It will be found that simplicity of system, so long as it is adequate, always pays, and, apart from this, I fail to understand why any charges (other than those associated with the actual purchasing) should be made against material.

In the engineering industry generally all "on-cost" is added to labour, and there appears to be no reason why the foundry should adopt a different attitude. It may be said that, whereas the material supplied to the engineering factory is ready for use, that supplied to the foundry must undergo a process (melting) before it is in a workable state, and that, as a consequence, the expenses associated with melting must be borne by the material.

This may be sound logic, and I am open to conviction, but at the moment the reasons are not so clear as they might be. The factory is definitely concerned with labour—every movement is occasioned by labour, and the factory is designed and equipped to give facilities to labour. The material, no matter in what state it is purchased, must have labour expended upon it, to a greater or a lesser degree, and, proportionately, the more crude the metal the cheaper is the purchase price, and the more expensive is the labour necessary to transform that material into the marketable commodity with which the factory is associated.

In the engineering factory the material as purchased must undergo a preliminary process to make it suitable for the recognised manufacturing operations. Bar material must in some instances be sawn into lengths suitable for the machine, and for this purpose a power saw is installed in the store and the storeman is responsible for the process. Yet the cost of the power and the time of the storeman is not charged against the material, but against the actual productive labour, because it is this labour which benefits. Sheet metal is purchased in sheets of standard dimensions and is cut upon a guillotine into workable sizes. The power necessary for running that guillotine, and the operator's time, is not charged against material, but against productive labour. The smith works on bar material and transforms this into a definite article, but he has the assistance of a forge, which burns coke or breeze. Yet this coke or breeze is not charged against the material, but against labour.

Are things different in the foundry? The metal must be melted, and a cupola is necessary for the purpose. It is, however, for the purpose of assisting productive labour, and the costs incurred must be charged against that labour. If material is to bear a share of "on-cost," what is the determining factor? If the furnaceman's wages are charged against material, what of the wages of the labourers who unload the metal upon arrival, and who assist the furnaceman to charge the cupola? What of the wages of the store-keeper and the wages of the crane-driver? The whole is a mass of complications, and at the best the apportionment can only be approximate.

Is it worth while? The material is purchased at a definite price, and the cost of productive labour is easily ascertainable "On-cost" is determined by the facilities provided to assist labour, whether these facilities aim at improving the state of material (for working purposes), storage, transportation or systematic handling, etc. The aim of management is to ensure economical production by the elimination of unnecessary effort and superfluous energy, and this means that the actual producer must be a whole-time producer.

The "aids" provided determine the efficiency of the producer, and the costs of all "aids" must therefore be charged against him.—Yours, etc.,

M. E. NICHOLLS.

The New Export Credit Scheme.

Some important extensions and modifications have now been made in the Export Credits Scheme under the provisions of the Trade Facilities Act which has recently passed through Parliament, supplemented by certain administrative changes in the regulations governing the scheme.

The scheme is now applicable to any country in the world, excepting British India, Ceylon and the Straits Settlements, where there are large unabsorbed stocks and where it has been represented to the Department of Overseas Trade that banking facilities are adequate for the trade to be done, and excepting Russia.

The latest date by which credits must be liquidated has been extended from September 8, 1925, to September 8, 1927. The Export Credits Department, therefore, is in a position to consider applications in respect of contracts, such as engineering and constructional contracts, involving the provision of credit over periods up to close upon six years. The date up to which new credits may be granted remains unaltered—viz., September 8, 1922.

A new system described in the regulations as "General Credits" has been introduced for the granting of credits, with a view especially to facilitating the utilisation of the scheme by merchants doing business in British goods on short-term credits. Hitherto an exporter has had to submit to the Department each specific transaction in respect of which a credit is required, and in the case of several classes of business this procedure has been found cumbrous in practice. The Department is now prepared to consider applications from exporters for general credits up to specified amounts in respect of specified countries and for specified periods. *The application must be submitted through the exporter's bankers.* The amount in respect of which the Department will be prepared to give guarantees will be decided in consultation with the Department's Advisory Committee set up under the original Act. The exporter will then be at liberty to enter into transactions abroad up to the amount fixed without further reference to the Department, and the Department will undertake to guarantee the bills drawn within the agreed period for the goods shipped. The bills thus carrying the Department's guarantee are regarded in the discount market as first-class bills. The bills should have as short a duration as possible, but renewals will, if necessary, be permitted provided that the total duration of the credits shall in no case exceed 12 months in all. In the case of these general credits, the Department will not require that security should be put up by the importer, but in event of default will retain recourse against the exporter for 57½ per cent. of the ultimate loss.

Hitherto the Department has only guaranteed up to a maximum of 85 per cent. of the total amount of the bill. The Department is now authorised to guarantee up to the full 100 per cent. in cases where the credit does not exceed 12 months in all; but in cases where the credit exceeds 12 months the Department will continue its present practice of not guaranteeing more than 85 per cent. of the amount of the bill. In other words, the Department will guarantee the full 100 per cent. under the "General Credits" system in all cases, and under the system of credits for specific transactions may guarantee up to 100 per cent. in those cases where the credit does not exceed 12 months. Credits will be granted for sums however small, as well as for large amounts.

A commission will be charged to meet administrative expenses and to form a pool to meet losses. The commission will vary according to the nature of the business and the countries concerned, but every effort is made to secure that it should be as small as possible.

The Department wishes to make it clear that the scheme is designed to finance actual sales, and the Department is not empowered to finance the carrying of stocks either in the United Kingdom or abroad; nor is it proposed to give credits in respect of goods to be shipped on consignment.

Copies of the detailed regulations can be obtained from, and inquiries should be addressed to, The Manager, Export Credits Department, 73, Basinghall Street, London, E.C.2.

Cast Iron for Foundry Purposes.*

By Frank S. Wilkinson.

Inherent Properties.

There is very little doubt but what the general opinion will be that the quality of the pig-iron produced to-day is not equal to that made years ago.

When furnaces worked with cold blast at a low pressure, the reduction of the iron from its ore was slowly carried on, the materials charged into the furnace were of selected quality, the make was small, and consequently the iron produced was of high class quality.

Staffordshire always has had a great reputation for cold blast pig-iron, and for special purposes there is still a market for this class of iron.

It will readily be admitted that the slower the rate at which the furnace is worked the better will be the product. Present-day requirements call for large outputs, and for ordinary purposes the iron produced quickly no doubt meets the demand, but the quality of the iron does suffer when made at a rapid rate, even though it be made from the same class of raw materials. The smaller furnaces producing good class irons make up to, say, 500 tons per week in a blowing period of, say, 160 hours, so that the rate of production per hour would be 3.125 tons, while in a furnace producing 1,500 tons per week with the same blowing period, the rate of production would be 9.375 tons per hour. The materials would therefore be in the furnace a considerably shorter period than would be the case in the smaller furnace, and consequently what may be called the purifying effect would not be exerted to the same extent, and though possibly iron of a similar analysis may result in each case, the slowly made iron has some property which is wanting in the iron produced rapidly.

The Suitability of Cast Iron for Foundry Purposes.

In this connection the first consideration is, of course, the class of casting the iron is intended for, and attention must therefore be paid to the chemical composition and physical properties of the iron used.

It is well known that the constituents of cast iron have a great effect upon the properties, and in modern practice a proper understanding of the influences of such elements as carbon, silicon, sulphur, phosphorus and manganese is essential.

In selecting pig-iron for use in the foundry, the time-honoured system of selection by fracture still obtains in many works, but it is good to know that the practice is being largely discontinued in modern foundries and more attention paid to grading and mixing by analysis.

While agreeing with the more scientific method, it must be admitted that castings of excellent quality were, and still are, made by the men who relied on the selection by fracture and a knowledge that the brand of iron used was a reliable one.

The founder who relies on this method is no doubt limited in his selection of the brand of iron he uses, and his position is only secure while he is able to get regular deliveries of the particular iron he selects.

Probably with old-established high-class brands this system can be used with perfect satisfaction, which must be the justification for continuing the practice.

The Influence of Elements.

Carbon. — For practical purposes the iron-founder considers this element as existing in cast iron in two forms, viz., graphitic and combined. It is now universally recognised that in molten cast iron the carbon is present in its combined state, and it will depend largely upon the rate of cooling and the percentages of other elements present, whether the carbon will separate out as graphite or retain its combined condition.

The total carbon in foundry pig-iron usually runs from 3 to 4 per cent., and it may be taken that the lower the total carbon the stronger will the casting be, always providing that the graphitic and combined are in the proper proportions. The effect of graphitic carbon is to cause the iron to have an open grain, and if the crystals are large planes of weakness are formed and the iron suffers in strength. The smaller the crystals of graphite, providing the silicon content is right, the tougher the iron will be. The question of the size of the crystals on the strength of cast iron has been investigated on several occasions, and the work done by Messrs. Cook & Hailstone in this respect is worthy of careful consideration.

Combined Carbon.—This is no doubt the element which, within limits, gives to cast iron hardness, density, strength and chilling property. It closes the grain, and in this respect bears considerable importance to the size of the crystal grains. It is, however, an element likely to cause the iron-founder great trouble if in excess for certain classes of castings, and its results will be specially felt in the machine shop when castings have to be machined.

Trouble has been experienced by the author on several occasions during the last two years owing to the high percentage of combined carbon in some brands of No. 1 Bessemer hematite from the West Coast.

In nearly every case the fracture of the pig-iron showed large crystals, and the combined carbon in such a pig-iron was naturally expected not to exceed 0.3 per cent., but it was found in many instances to be over 0.6 per cent., and in at least one case to be over 0.7 per cent.

The analysis of two of these irons which are taken from the pig-iron itself and not after re-melting through the cupola showed:—(1) C.C., 0.533 per cent.; Si., 2.157 per cent.; S., 0.058 per cent.; and Mn., 0.876 per cent. (2) C.C., 0.667 per cent.; Si., 2.511 per cent.; S., 0.06 per cent.; and Mn., 0.13 per cent.

It is probable that the use of foreign ore high in manganese may account for it, but samples showing only 0.186 per cent. manganese contained 0.725 per cent. combined carbon, while other samples containing a content of manganese over 1 per cent. showed combined carbon of 0.38 per cent., the silicon in each case was normal for No. 1 Bessemer hematite.

Of course, this question of combined carbon in hematite pig-iron would not affect the iron for steel-making purposes, but it is rather a serious matter for the foundryman who has to make special castings which have to be subjected to repeated heating and cooling, as it is likely to be the cause of many failures in use.

Silicon.—This is the element which has a great influence on the condition of the carbon, its tendency being to cause the separation of the graphite. To a certain extent it weakens cast iron but promotes soundness and fluidity; it also acts as a softener and prevents chill.

When present over 4 per cent. it reduces the power of the iron to absorb carbon during reduction in the blast furnace, and it will be found that the higher the percentage of silicon the lower will the total carbon be. This is noted in the siliceous pig-iron sometimes used in the foundry as a softener, and is also borne out by the fact that ferro-silicon made in the blast furnace, where the silicon may be as high as 20 per cent., the carbon is usually well under 2 per cent., and is in the graphitic condition.

Sulphur.—The effect of sulphur is entirely opposite to that of silicon. It tends to prevent the separation of the carbon as graphite, thereby making the metal harder and increasing the shrinkage.

Within limits it strengthens cast iron, and any harmful effects it may have are considerably lessened in the presence of manganese.

Its tendency to retain the carbon in the combined condition causes it to have a chilling power, and the percentage present in strong castings may be as high as 0.12 per cent. without seriously affecting the strength, while the wearing properties will be improved.

Cases have occurred where iron containing silicon 1.025, manganese 0.5, and sulphur 0.12 per cent. gave a transverse strain of 40 cwt., with 7-16 deflection and ⅛ in. chill, while iron with silicon 1.46, manganese 0.66, and sulphur 0.07 per cent. only gave a transverse strain of 28 cwts.,

* Extract from a Lecture read before the Staffordshire Iron and Steel Institute on Saturday, December 17.

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5-16 in. deflection, and no chill at all, although as a rule it is found that high sulphur decreases the transverse strain.

Sulphur is usually looked upon as the iron-founder's greatest enemy, and many failures are put down to its presence in castings.

Sulphur is undoubtedly a source of great trouble, especially to the founder who produces castings which have to be machined, for it is without doubt a fruitful cause of hard metal and blow-holes, but it is not sure that it is the "bogey" that many would have us believe, and for some classes of castings it may, within limits, be a distinct advantage.

A recent specification for high sulphur foundry pig-iron of the following analysis:—Total carbon, 2.25 to 2.75; silicon, 2.5 to 2.75; phosphorus, trace to 0.05; sulphur, 0.25 to 0.75; and manganese more than 0.25 per cent.

It is not known if the iron was supplied, but it would seem to point to the fact that someone was not afraid of the high sulphur content.

It will generally be found that the sulphur increases as the silicon decreases.

Phosphorus.—This element is of great importance, for whilst its presence promotes fluidity and thereby enables very thin castings to be run, it has a weakening effect upon the metal when present in excess, and over 1.5 per cent. makes the iron very hard and brittle.

Fortunately, the phosphorus content in pig-iron from various furnaces is fairly regular, as practically the whole of the phosphorus in the ore from which the pig-iron is made will enter the iron, so that the selection of pig-iron for foundry purposes can be made without much trouble as far as the percentage of phosphorus is concerned.

It is not an important factor in castings where strength is not of first consideration, and if all the other elements of cast iron were as well understood a great amount of the foundryman's trouble would be solved.

In castings which have to be subjected to high temperatures this element should be as low as possible, because the phosphorus exists in foundry pig-iron as a fusible phosphide, which is the first constituent to melt, and the higher the percentage of phosphorus the lower will be the melting point.

This phosphide is the last constituent to solidify, and in iron containing a high percentage of phosphorus there is a tendency for the phosphide to become surrounded by the other elements which solidify first, a reduction in the strength of the castings is the result; particularly is this the case with castings which are subjected in use to shock or impact. For strong castings 0.6 per cent. is about a safe limit.

Manganese.—This element has a great affinity for carbon, and its power to combine with that element and causing it to be kept in the combined condition results in higher percentage of combined carbon on re-melting, with a consequent hardening of the metal. Shrinkage is increased and chilling properties are imparted.

The question of the influence of manganese on foundry iron must be considered with that of sulphur, which is greatly affected by the presence of manganese.

The manganese is found to be present either as manganese sulphide or iron manganese carbide. Its affinity for sulphur is an advantage, as in the case of high sulphur it will tend to combine and form manganese sulphide, which, if time is given, will rise to the surface of the molten metal and form a scum or slag. This combination will more readily take place at a high temperature, so that hot melting is necessary to take advantage of this form of desulphurisation.

Manganese sulphide is not so harmful as the iron manganese carbide, which, according to Moldenke, is the form which causes trouble when castings come to be machined owing to it being hard and granular.

In considering the effects of the elements already mentioned, it is also necessary to take into account the effect of re-melting the iron through the cupola.

It is generally found that this results in a decrease in the amount of silicon and manganese, due to oxidation, and an increase in the sulphur which it picks up from the coke.

Phosphorus may be increased slightly, while the total carbon will not be very much altered.

In this connection the following table is interesting as showing actual working results:—

TABLE I.—*Showing the Influence of Remelting.*

	Case 1.		Case 2.	
	Increase Per cent.	Decrease Per cent.	Increase Per cent.	Decrease Per cent.
T.T. ..	—	0.295	0.395	—
Gr. ..	—	0.680	0.190	—
Ci ..	0.385	—	0.205	—
Si ..	—	0.443	0.028	—
S ..	0.052	—	0.012	—
P ..	0.038	—	0.011	—
Mn ..	—	0.170	—	0.286

The decrease in the total carbon in the first example is worth notice, as the total carbon in the original iron was 3.145 per cent., while on the re-melt it was only 2.85 per cent.

It has been stated that the total carbon cannot be reduced below 3 per cent. when melting through the cupola, whatever may be the percentage present in the original iron used, or the amount of steel scrap added to the mixture.

In the case under notice no steel scrap was added, but yet a lower total carbon than 3 per cent. resulted, which, however, is outside the usual practice.

It will also be seen that the silicon increased in the second example given, but this again is an exception to the general rule.

The conditions under which the cupola working is carried on will have an effect upon the increase or decrease of the various metalloids; for instance, if dull and slow melting is taking place, there will be a larger amount of sulphur taken up from the coke.

Chilling Properties.

For such purposes as rolls, car wheels, brake blocks, stone crushers, etc., there is a demand for pig-iron which will give a hard and regular chill when cast against an iron mould. Some reference has already been made to the effect of various constituents on the chilling properties, and in order to obtain good results it is necessary that careful selection of iron should be made having regard to the purposes for which the chilled castings are to be used.

The proper control of the silicon and carbon appears to produce the most satisfactory results, both from the point of view of regularity of the depth of the chill, hardness, and wearing properties.

Both sulphur and manganese will have the effect of producing a deep chill, but the castings which have had their chilled surface produced by either of these elements in excess will not be found to give such satisfaction in working as in those cases where the chill is the result of the effect of silicon and combined carbon, with sulphur and manganese present in the normal percentage for the class of iron used.

A good chill should show a gradual change in the appearance from white to grey, with intermediate mottled, so as to give what the roll maker calls a good "back." Probably this can best be secured by using pig-iron smelted direct from ironstone through the blast furnace, rather than a refined iron in which the silicon and carbon have been artificially affected by the introduction of steel scrap or some other medium.

The temperature at which the iron is cast and also the thickness of the iron mould must be taken into consideration; if the iron is poured at a high temperature, the depth of chill is likely to be greater than from the same iron poured at a lower temperature.

Good iron does not always result in good castings, for all the problems and difficulties met with in the foundry are by no means confined to the iron used, neither are all the troubles solved by chemical analysis, and it will only be by continued systematic research that light will be thrown on troubles that up to the present have proved past solution.

The formation of the British Cast Iron Research Association is a move in the right direction, and we may look forward with confidence to much good work being accomplished for the benefit of the foundry trade throughout the country.

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The Problem of Grey Iron Castings.*

By H. J. Young, F.I.C.

Long before scientific control was thought of, or needed, ironfounding was carried on by rule-of-thumb methods—and very little change is to be observed in the majority of iron foundries in this country to-day.

neglected the material that rendered most of those structures commercially possible, namely, cast iron.

Modern foundrywork is the sum total of thousands of little alterations by past generations of workers. Hundreds of men of widely different

TABLE I.—*Showing the Variations of Phosphoric Irons.*

Type of pig-iron.	All consignments.			Number of pigs sampled.	Total variation.			
	Total No.	Total period.	Total weight.		Silicon.	Phosphorus.	Sulphur.	Manganese.
DURHAM and NORTHUMBERLAND—		Years.	Tons.		Per cent.	Per cent.	Per cent.	Per cent.
—No. 3	8	1913–14	475	25	1.9 to 3.2	1.2 to 1.6	0.01 to 0.06	0.5 to 0.7
Same	51	1916–20	2,282	309	1.6 to 5.0	1.1 to 1.7	0.01 to 0.13	0.4 to 0.8
As advertised	—	—	—	—	(2.8)	(1.5)	(0.04)	(0.6)
—No. 3	13	1912–14	465	46	2.1 to 2.9	1.2 to 1.7	0.01 to 0.06	0.5 to 0.7
Same	50	1915–19	779	165	1.6 to 3.9	1.4 to 1.7	0.02 to 0.09	0.4 to 0.7
As advertised	—	—	—	—	(2.6)	(1.4)	(0.02)	(0.5)
—No. 3	7	1911–14	306	28	1.9 to 3.6	1.0 to 1.7	0.02 to 0.06	0.5 to 1.1
Same	17	1915–19	523	55	2.6 to 4.3	1.0 to 1.5	0.01 to 0.07	0.6 to 1.3
As advertised	—	—	—	—	(2.0–3.0)	(1.1)	(0.04)	(0.5)
—No. 4 Foundry	8	1918	499	39	2.1 to 3.9	1.4 to 1.6	0.02 to 0.10	0.5 to 0.8
As advertised	—	—	—	—	(1.7–2.5)	(1.1)	(0.07)	(0.5)
—No. 4 Forge	4	1918	250	31	0.6 to 2.5	0.9 to 1.4	0.05 to 0.34	0.4 to 1.3
As advertised	—	—	—	—	(1.0–1.7)	(1.1)	(0.09)	(0.5)
CLEVELAND—								
—No. 3	13	1917–18	297	43	2.3 to 3.7	1.5 to 1.9	0.03 to 0.08	0.4 to 0.6
As advertised	—	—	—	—	(2.5–3.0)	(1.5)	(0.05)	(0.6)
—No. 3	1	1918	81	18	2.3 to 3.5	1.2 to 1.8	0.02 to 0.04	0.4 to 0.6
As advertised	—	—	—	—	(3.0)	(1.5)	(0.03)	(0.6)
—No. 3	2	1918	72	15	2.5 to 3.6	1.5 to 1.7	0.02 to 0.07	0.5 to 0.7
NORTHAMPTONSHIRE—								
—Basic	27	1918–20	415	110	1.1 to 2.6	1.4 to 1.8	0.02 to 0.13	0.8 to 1.9

TABLE II.—*The Variations of Hematite Iron.*

Type of pig-iron	All consignments.			Number of pigs sampled.	Total variation.			
	Total No.	Total period.	Total weight.		Silicon.	Phosphorus.	Sulphur.	Manganese.
DURHAM and NORTHUMBERLAND—		Years.	Tons.		Per cent.	Per cent.	Per cent.	Per cent.
—No. 3	15	1916–19	382	53	1.7 to 4.6	0.01 to 0.6	.02 to .09	0.6 to 1.8
As advertised	—	—	—	—	(2.0-2.5	(.05 max.)	(.06)	(1.1 max.)
—High silicon	3	1915–18	35	15	2.6 to 3.8	.02 to 0.4	.01 to .03	0.8 to 1.8
As advertised	—	—	—	—	(2.5-3.0)	(.04 max.)	(.03)	(1.2 max.)
—No. 4	6	1920	83	33	0.7 to 1.5	.09 to .27	.09 to .27	0.6 to 1.0
As advertised	—	—	—	—	(about 1.0)	(about .06)	(.10-.15)	(about 0.7)
—No. 5	7	1919–20	112	44	0.3 to 1.4	.01 to .07	.11 to .40	0.3 to 0.9
As advertised	—	—	—	—	(0.7–1.5)	(.06)	(.10–.25)	(about 0.8)
CLEVELAND—								
—High silicon	22	1920	493	125	1.7 to 4.5	.02 to .05	.01 to .11	0.7 to 2.0
As advertised	—	—	—	—	(3.0–3.5)	(below .05)	(.01–.05)	(above 1.5)
—No. 1	7	1919–20	200	48	2.5 to 3.8	.02 to .05	.01 to .07	0.6 to 1.4
As advertised	—	—	—	—	(3.0–3.5)	(below .05)	(.01–.05)	(above 1.5)
—No. 3	12	1913–14	199	44	1.4 to 4.5	.01 to .07	.01 to .12	0.7 to 2.1
Same	63	1915–20	1,332	234	0.8 to 5.3	.01 to .08	.01 to .19	0.5 to 1.8
As advertised	—	—	—	—	(2.0–2.5)	(below .05)	(.01–.05)	(above 1.3)
—No. 4 Forge	9	1913–14	109	30	0.9 to 1.7	.01 to .07	.07 to .14	0.8 to 1.4
Same	20	1915–20	438	85	0.7 to 2.4	.02 to .07	.04 to .30	0.4 to 1.7
As advertised	—	—	—	—	(1.0–1.5)	(below .05)	(.10–.15)	(above 1.2)
—No. 3	4	1911–14	39	13	1.7 to 2.4	.02 to .05	.01 to .04	0.3 to 1.2
Same	2	1915	25	6	1.7 to 2.7	.02 to .04	.01 to .04	0.8 to 1.3

TABLE III.—*The Variations of Scotch Irons.*

Type of pig-iron.	All consignments.			Number of pigs sampled.	Total variation.			
	Total No.	Total period.	Total weight.		Silicon.	Phosphorus.	Sulphur.	Manganese.
SCOTLAND—		Years.	Tons.		Per cent.	Per cent.	Per cent.	Per cent.
—No. 3	7	1911–14	345	25	2.2 to 3.8	0.4 to 1.0	0.1 to 0.3	0.9 to 1.6
As advertised	—	—	—	—	(2.8)	(0.6)	(0.02)	(1.4)
—No. 3	77	1916–19	972	160	1.8 to 4.8	0.6 to 1.3	0.01 to 0.11	0.8 to 2.8
As advertised	—	—	—	—	(2.3)	(0.7)	(0.04)	(1.9)
—No. 3	6	1912–14	130	22	1.8 to 3.5	0.5 to 0.9	0.01 to 0.07	0.5 to 1.6
As advertised	—	—	—	—	(2.7)	(0.8)	(0.03)	(0.8)
—No. 4	6	1911–12	92	22	1.6 to 3.6	0.6 to 0.8	0.02 to 0.11	0.5 to 1.2
As advertised	—	—	—	—	(2.0)	(0.7)	(0.06)	(0.9)

What engineering owes to cast iron can be reckoned in terms of what engineering would be now if cast iron had never been, but while the engineer has used every possible resource of academic and applied science to the end of making his structures capable of greater things he has

experience, education, and calibre have contributed to these alterations, day by day and year by year, until now; the result being a trade wonderful in its empirical experience and behind all other trades in its scientific knowledge.

Without demand for science there has been little supply, and the building-up process has necessarily gone on without it. Thus have safety factors,

* Paper read before the Institute of Mining Engineers December 13, 1921.

thicknesses, rule-of-thumb mixtures, belief in certain pig-irons, specifications of test-bars and so forth been adopted and established to the degree of being almost beyond the criticism of those in power in most works.

That the ironfoundry trade will eventually walk in the paths of progress nobody doubts, also it may happen that sudden convulsive evolutions will occur as have occurred in the past in many other industries, for example, steel making and soap manufacturing. New materials are wanted to meet new conditions; an unscientific trade is being asked to cater for a scientific one; the engineer has, with one hand, locked his door against metallurgical science while, with the other, he has welcomed and embraced the science of engineering. He is now, in consequence, in the unfortunate position of having the latter asking for more than the former knows how to give.

The Composition of Pig Iron.

Two instances alone should be sufficient to convince anyone as yet sceptical. The engineer uses a safety factor for cast iron, regardless of whether it may be 8-, 12-, or 16-ton metal; he has deliberately agreed to look upon cast iron as an unreliable material. The second instance is that of the engineers' acceptance of the rule-of-thumb mixture. It is well known that pig irons vary from consignement to consignment, yet no matter whether he has been a maker, buyer, or user, the engineer has shut his eyes to the fact that by no possible conjuring could the rule-of-thumb mixture give him metal of known or standard quality.

A consignment of any ordinary pig iron is little more homogeneous than one of mixed scrap. Out of many hundreds of consignments of different brands the author has not found an exception.

For instance, of three consignments of No. 3 pig iron, 350, 280, and 280 tons respectively, the silicon varied in a dozen pigs taken at random from 2.1 to 2.4 per cent. Of the second consignment the variation was 2.4 to 4.7 per cent. on 23 pigs, whereas in the third lot 25 pigs were shown to contain anything between 2 and 3.9 per cent.

These figures show that no two consignments possess similar or equal variations, and that it is impossible to predict the composition or to strike a reliable average. That this is so is recognised by the makers and sellers of pig iron, who will exploit the wonderful properties of their irons but, in the same breath or on the same paper, will disclaim any responsibility or guarantee for the iron they supply having the same composition as the iron they advertise and recommend. To purchase an iron upon its published composition is to buy a pig in a poke.

Variations in the silicon- and sulphur-contents in one consignment of a No. 4 pig iron may be typified by the results which were obtained by analysing 21 pigs from a 200-ton consignment where the former varied from 0.6 to 2.4 per cent. and the latter from 0.10 to 0.34 per cent.

The cheapest grey pig irons are very full of impurities and consequently show the least variation. Tables I., II. and III. are a tabulation of years of practical work upon many brands of pig iron—phosphoric, hematite, and Scotch irons respectively.

In the above tables the results obtained prior to the war have been separated from those obtained during and since the war, and it will be noticed that, so far as actual variation is concerned, the irons are little better or worse in either period. Also below each kind of iron are shown certain figures enclosed in brackets—these are the makers' published compositions.

Attention is called to these three tables. They represent ten years' supervision of the pig irons used in two iron foundries; they cover over 400 consignments of 11,000 tons total weight; they represent 22 different kinds of pig iron; and, finally, they show the results of complete duplicate analyses of more than 1,000 separate pigs. Many other brands have passed through the author's hands, but in no instance has he found a pig iron with a constant ultimate composition, or with an ultimate composition as advertised, or with an ultimate average composition which one could predict before analysing. Total carbons are not shown in above tables, although hundreds upon hundreds of estimations have been made; it is impossible at present to say what is the average content of carbon in any particular kind of ordinary pig iron.

Too much stress cannot be laid upon the deductions to be drawn from the above tables. Once and for all can the engineer cast overboard all faith in rule-of-thumb mixtures made from pig irons of constantly varying composition. Pig iron of standard ultimate composition would solve nearly all the difficulties of the jobbing foundry and most of those of the foundries doing more important castings—which remark applies equally to all branches of engineering and to all types of castings.

It is unfortunately necessary to point out that troubles do not always cease upon the cessation of rule-of-thumb methods, as everything depends upon whether they have been discarded for better ones, and, as will be shown later, this is seldom the case.

Table IV.—*Demonstrating the Possibility of Controlling Composition.*

Casting.		Strength.		Carbon.			Other elements.			
Date.	Weight	Tensile.*	Transverse.†	Combined.	Free.	Total.	Si.	P.	S.	Mn.
	Tons.	Tons sq."	Lbs.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
May 7th	17	11.5 (flaws)	2,739 (flaws)	0.78	2.61	3.39	1.67	0.63	.064	0.85
„ 15th	11½	14.0	2958	0.78	2.54	3.32	1.75	0.68	.069	0.88
„ 22nd	11	12.5	2,799	0.79	2.58	3.37	1.75	0.60	.057	0.91
Aug. 11th	4½	11.6 (flaws)	3,116	0.73	2.66	3.39	1.69	0.54	.067	0.83
„ 23rd	13	13.8	2,779	0.82	2.51	3.33	1.74	0.51	.066	0.95
Sept. 6th	12½	13.0	2,938	0.76	2.59	3.35	1.68	0.56	.077	0.82

* Bars cast 1 inch diameter and machined to 0.789 inch diameter.
† Bars cast 1½ inch square and machined to 1 inch square and tested between supports 12 inches apart.

Standard Castings are Possible.

Nevertheless, castings of nearly standard composition can be produced even under the dubious conditions of cupola control to which, for lack of measuring instruments, we are still subjected. As a practical and typical instance may be quoted some important turbine castings made this year of which the metal was required to give 11 tons tensile and 2,500 lbs. transverse strength—the test-bars being cast on the castings and verified in the usual way. This series of castings is given in Table IV., and it is interesting to note that no pig iron as expensive as Scotch iron was used, and that owing to one or two of the constituents running short the mixture was changed from time to time.

The above figures being obtained from test-bars attached to the castings themselves prove that much can be done to standardise cast iron even in large work, and even with our present lack of knowledge. Very few foundries do this, and equally few engineers appear to have grasped the importance of being able to do it. Progress is well-nigh impossible so long as no two castings are alike in composition. Unusual failures or successes arise out of departures from the normal state, and in order to study the properties of any one type of cast iron, and there are hundreds of types, we must be able to reproduce it at will, time and time again. So far as the author has obtained samples he has found no foundry turning out standard cast-iron castings for marine work nor for any other work.

Turbine Castings.

Undoubtedly the first step towards the understanding of cast iron is the control of its composition under ordinary foundry conditions. Some firms are establishing the method of superheating the cupola-melted metal in an electric furnace, while others, mainly abroad, use an open-hearth air furnace. Good as these methods may be they do not in any way alter the fact that if the cupola-melted metal is out of control any subsequent treatment of it is merely patching up a bad job. If the cupola is to be used at all then the production of cupola-melted metal to any required composition is essential. The turbine castings shown in Table IV. are merely given as examples of controlled compositions as compared with the opposite of controlled compositions as shown later on under the subject of castings for Diesel engines. This control of composition is merely a matter of experience and knowledge, and the day will come when we shall be able to specify cast iron exactly as is done now with steel, and that without the help of any other furnace than the cupola.

The Possibilities of Duplexing.

In connection with the use of an electric or other furnace in conjunction with a cupola there are several important points to keep in mind. Firstly comes the fact that what we know about cupola practice is insufficient to enable us to predict that what we require cannot be obtained from a cupola. It is a wonderful furnace and very little reliable work has been done upon it, far too little to justify us in discarding its use or in rushing into anything involving higher costs of production. Secondly, castings have to be produced at prices which will compete with those of the foreigner; electric power is not cheap in this country, and the upkeep of electric furnaces is no small matter. Lastly, it is not to be immediately assumed that the more carbon, phosphorus, and sulphur we abstract from the iron the better will be the metal for the purposes of making castings. Empirical or rule-of-thumb methods and reasoning have thus far failed to produce reliable cast iron, and there seems to be a tendency, even among chemists, to throw over the metal known as cast iron and to aim at something of lower carbon-content than the cupola will produce and more like steel. The time does not seem to be ripe for any such thing, and scientific effort would better be directed towards producing improved and standard cast iron from the cupola without any other furnace or any other treatment. At great expense it seems quite an easy task to make improved metal, but if applied science is to justify itself in the world of cast iron it must produce the material at prices such as will enable castings to command the markets here and abroad.

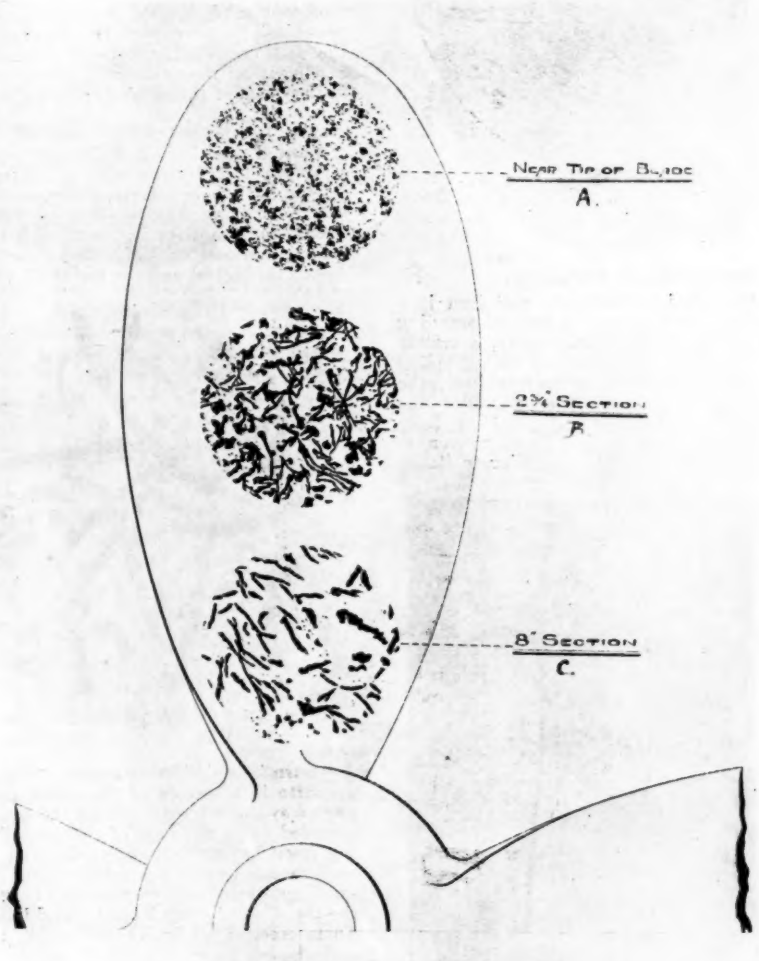


FIG. 1.—PROPELLER. SHOWING VARIATION OF GRAPHITE ACCORDING TO POSITION. MAGNIFIED 12 DIAMETERS.

It is common knowledge that ordinary grey iron is white or nearly white when it is chilled instead of being cooled slowly in the usual sand moulds; also is it well known that the smaller the section of the casting the closer is the grain of the metal and the harder the metal. A 20-ton cylinder casting, after being broken up, shows innumerable types of grain, varying according to the section and according to the cooling conditions of that particular part of the casting.

The metal flowing from the cupola is saturated with combined carbon; it is like extremely high-carbon steel and therefore, when drastically chilled, the metal is white and unmachinable. If, however, the cooling is slow, then the iron cannot hold all its carbon, and throws some of it out in the form of graphite flakes or plates—this happens immediately the metal begins to go solid and continues as it cools through its critical ranges.

The slower the cooling the longer time does the metal have in which to free itself of carbon, and consequently the more numerous will be the flakes of graphite, and, in some cases, the larger also will be those flakes.

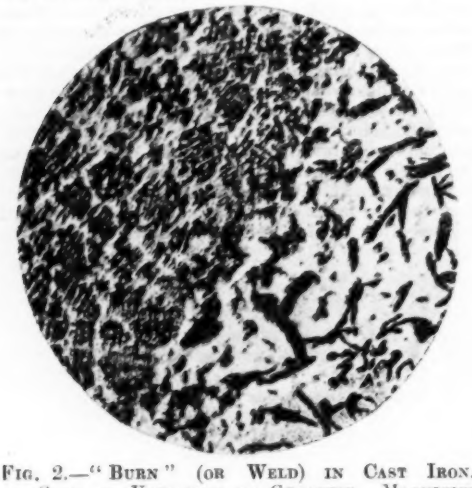


FIG. 2.—"BURN" (OR WELD) IN CAST IRON. SHOWING VARIATION OF GRAPHITE. MAGNIFIED 25 DIAMETERS.

Why Cast Iron is Machinable.

The logical conclusion that grey cast iron is a very high carbon steel cut up by and surrounding innumerable plates of graphite, namely, a matrix of steel containing many spaces filled with graphite —for this reason can cast iron be machined, the non-homogeneous material collapsing under the stresses produced by the edge of the cutting tool; for the same reason also, has it little or no elongation, and many other properties peculiar to itself.

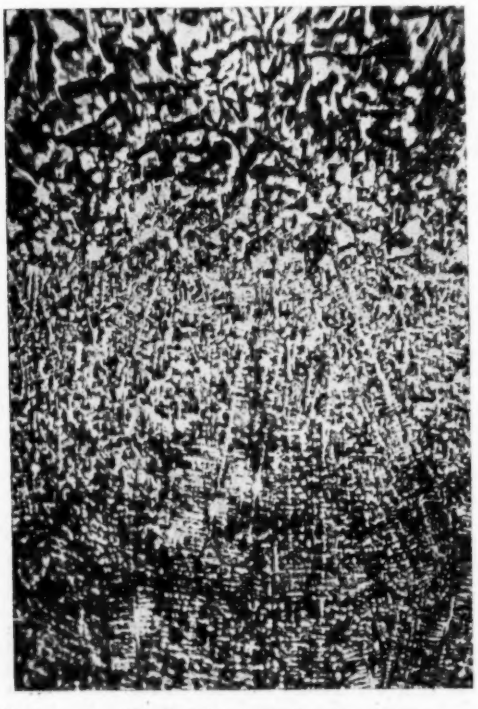


FIG. 3.—AS FIG. 2. SHOWING GENERAL STRUCTURE. MAGNIFIED 25 DIAMETERS.

Propeller Blades show cooling effects.

A practical object lesson of the truth of these generalisations is obtained from a large propeller casting, blades and boss complete, and weighing, say, 11 or more tons. Here the great mass of the boss causes extremely slow cooling of the adjacent parts, the effect getting less and less along the blades away from the boss and also the section of the blades themselves gets less. In practice, the molten metal flowing to the tips of the blades is almost chilled, and, therefore, the tips are very hard and brittle and contain but little free carbon. A short distance from the tip, this cooling is less severe and more carbon is released, with the consequence that the metal is grey but rather hard—the metal being as seen at "A" in Fig. 1.

Half-way up the blade the section is greater, and the heat given off by the cooling of the boss delays the cooling, hence the metal will be very normal and perfectly grey and machinable—as shown at "B." At the root of the blade, where it joins the boss, the cooling will be extremely slow, taking some hours probably, and therefore the iron has time to free itself almost entirely from combined carbon, and when cold is found to be full of large graphite—seen at "C."

Thus does a propeller casting demonstrate the fact that the quantity and size of the graphite is greatly ruled by the rate of cooling of the metal from hot solid to cold solid. It shows how impossible it is to expect the test-bar to represent the casting, also if the test-bar be cut out of the casting itself the result will be representative only of that part of the casting from which it was cut.

The Importance of Graphite.

Another practical example may be obtained from what the foundryman calls a "burn." When a casting is slightly defective it is sometimes possible to "burn" on a new piece by running molten metal over the defective part until the surface of the original casting begins to get molten, when the stream is checked and the metal allowed to solidify.

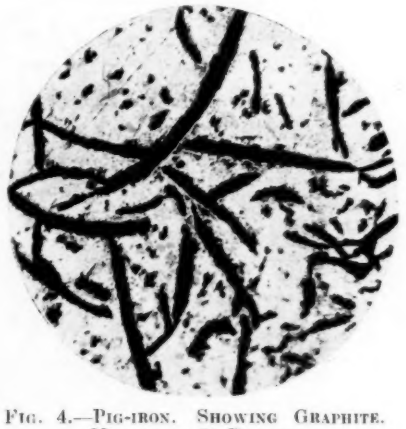


FIG. 4.—PIG-IRON. SHOWING GRAPHITE. MAGNIFIED 50 DIAMETERS.

A "burn" is similar to a weld. Fig. 2 shows the graphite in a section of the metal taken at right angles to the "burn," where the same effects are observed as in the case of the propeller—the casting itself having large graphite and the "burnt-on" metal, owing to rapid chilling, having very small graphite and very little of it. Of course, the metal will be much harder and less machinable. An interesting study is presented by the combined carbon and general structure of the "burn," as seen in Fig. 3, and fir-tree growth of long crystals being particularly noticeable and enlightening.

From the above it should be clear that the quantity, formation, size, and distribution of the free carbon or graphite have enormous effects upon the properties of the metal. The photographs shown in Figs. 4, 5, and 6 give an idea of some different kinds and formations of graphite. Considering the large number of flakes there is to the cubic inch of cast iron it is not surprising that the question of graphite is an important one, though little is known about it up to the present.

The matrix of iron, in which the graphite occurs, contains the remainder of the carbon combined with it, and, under the microscope, this carbide is seen in thin layers or laminations having a characteristic appearance, by reason of which it has been christened "pearlite." However, should there be more than a certain quantity of combined carbon, namely, more than is required to form the greatest possible amount of these pearly layers, then the excess forms more definite and relatively thicker lamellæ, called "cementite"—which make up a kind of network structure throughout the material, dividing it, so to speak, into grains.

Test-bars.

The propeller casting mentioned above demonstrates that the graphite plates were larger in the slower cooled parts of the casting than in those cooling relatively quicker, and so also does the same appear to apply to the "pearlite" or combined carbon. An example of this may be obtained from the following case of a cylinder liner with test-bars cast on.

The particular liner mentioned here was about 3¼ tons weight including the "head." From this "head," which was about 4½-in. thickness of metal, a test-bar was cut and compared with the test-bar cast in shape on the casting.

Consequently a comparison of the same iron from the same casting reveals what differences have been caused by a casting-thickness of 4½ in. and one of 1 in. (namely, the test-bar cut out of the head and the test-bar cast on the casting)—both bars were machined to 0.798 in. diameter. Figs. 7 and 8 respectively show the graphite and the pearlite in the test-bar *cast on the casting*, while Figs. 9 and 10 show the same in the test-bar *cut out of the casting*. It will be seen that the graphite and pearlite in the former are small in size compared with those of the latter, the massive pearlite being particularly remarkable.

This cylinder liner metal is of interest because it has had some little success in actual service. Under superheat conditions, and even under ordinary conditions, ordinary liner metal leaves much to be desired, and the metal shown above was evolved gradually over a number of years of observation of the behaviour of various kinds of cast iron. Heavy and thick as are these castings, the test-bars cut out of them give nearly the same tests as the test-bars cast on them, namely, about 12 tons tensile and 2,300 lbs. transverse (on Admiralty square bar).

The metal has a low Brinell number in the neighbourhood of 212 or less, but cannot be cut with a hacksaw. It can be machined commercially in the shops at the rate of 45 ft. per minute with a depth of cut of ¼ in. by 1/32 in. feed per revolution.

(To be continued.)

FIG. 5.—CAST IRON. SHOWING ONE TYPE OF GRAPHITE. MAGNIFIED 50 DIAMETERS.

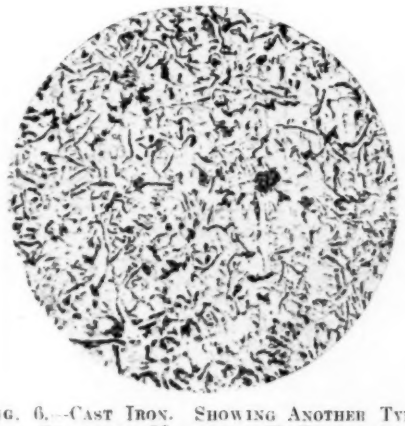


FIG. 6.—CAST IRON. SHOWING ANOTHER TYPE OF GRAPHITE. MAGNIFIED 50 DIAMETERS.

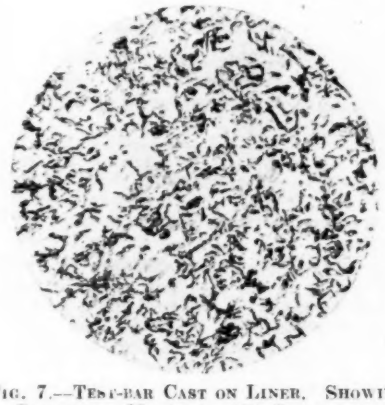


FIG. 7.—TEST-BAR CAST ON LINER. SHOWING GRAPHITE. MAGNIFIED 25 DIAMETERS.

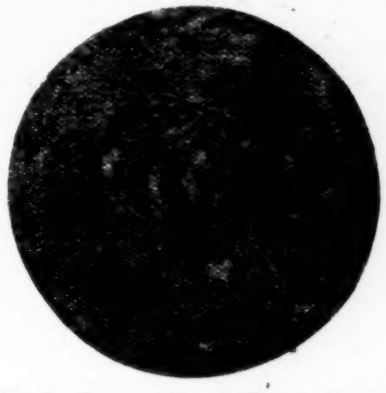


FIG. 8.—TEST-BAR CAST ON LINER. SHOWING PEARLITE. MAGNIFIED 1,100 DIAMETERS.

FIG. 9.—TEST-BAR CUT OUT OF LINER. SHOWING GRAPHITE. MAGNIFIED 25 DIAMETERS.

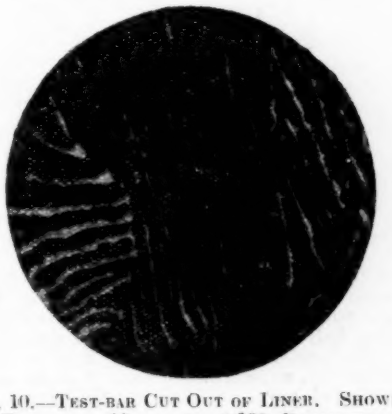


FIG. 10.—TEST-BAR CUT OUT OF LINER. SHOWING PEARLITE. MAGNIFIED 1,100 DIAMETERS.

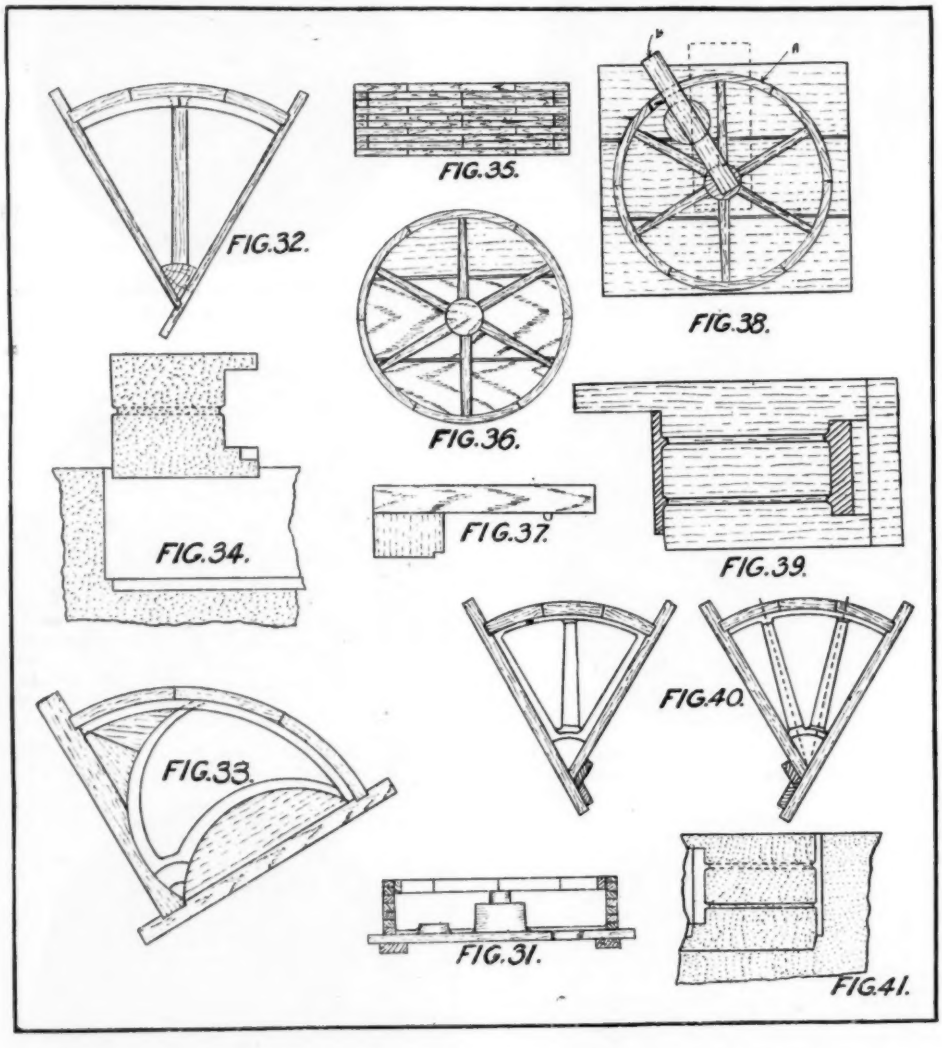
XUM

Belt Pulley Castings.—III.

By Ben. Shaw and James Edgar.

(*Continued from p.* 463.)

Two cores will be necessary for locating the parts, one recessed out of the bottom and the other equal in size secured to the bottom, as shown in Fig. 31. When the pulley is of large size then a different method of coring can be adopted with more satisfactory results. A larger number of sections would be necessary depending upon the number of arms. When the arms are straight a sectional core-box, such as is shown in Fig. 32, will answer the purpose, while for curved arms, the sides of the box instead of being straight are curved to follow the



centre lines of the arms, and the pattern sections are secured to them, as shown in Fig. 33. Even for the pulleys with straight arms the method of securing half sections of the arms to the sides is frequently preferred, but when the arm is carried in the centre, as shown, the amount of fin on the casting is reduced to a minimum. This cannot very well be avoided with curved arms because of the difficulty in stripping. When this form of core-box is used it is only necessary to have a bottom print on the pattern. A part section of the mould indicating the method of moulding is indicated in Fig. 34.

The neatest pattern-making of the five different forms of pulleys with which we are dealing is that for the double armed form, Fig. 5. (See page 439.) It does not present any great difficulty, but the coring requires careful watching. Figs. 35 and 36 are two views of a suitable pattern. The section, jointed in the middle, is built to the centre of the arms, as obviously it would be difficult to prepare a mould from a mould of the required casting. The plate, which is shown open jointed in Fig. 38, to localise any change of form due to the absorption of moisture, to set into a shelf, turned from the built ring, as it would not be satisfactory to carry it to the outside diameter. The remainder of the rim—the two top courses of segments in Fig. 37—can then be built on top of the plate, whilst the work is still secured to the face plate and afterwards turned. Yellow pine may be quite suitable for the rim of such a pattern, but the arms and boss should certainly be of mahogany. To facilitate coring, owing to the ribs not being in line, the core may be made in halves, jointed horizontally through the centre. A little care must be exercised in constructing the box, to prevent the moulder setting the core wrongly. It is necessary to screw circular prints between the arms of the pattern; the number used is not important providing corresponding places are cut out from the base-plate of the core-box. These are required for locating the core in its correct relative position, but to avoid confusion are not shown in the drawing. The outside of the core may be swept by means of the strickle, shown in Fig. 37, which consists of two pieces of wood, about 1¼ in. thick, half-lapped together. The pattern section of the boss is secured to the plate, and it is necessary to have a dowel-hole in the centre also; a row of segments may be secured to the base-plate, as shown in Fig. 38. It is evident that some expedient must be employed to ensure that the top and

bottom arms are in correct relation to each other, and a simple device serves the purpose. A. (Fig. 38) is a segment built the depth of the core, and in length the distance between two arm centres. This segment gives support for a joint in one case and a core in the other. The patten, B, which is dowelled to the centre-boss and the rim-segment. has a print secured to it. The dotted rectangular shape, shown on the sketch, indicates another batten, which is dowelled and drops into position when the other batten is removed and the second core is being made. This batten must, of course, be the same thickness as the print secured on batten B. If the pulley has, say, six arms, then the centre lines of these battens will be at 30 deg. to each other. If a great number of cores are required, it would be profitable to make two core-plates, but it is not often that large numbers are required of this design.

Whilst this method is adopted, another method can be profitably employed in preparing moulds for block pattern, the mould may be swept out by means of a sweepng board (Fig. 39) at the bottom. Then a sectional core box may be employed, it being prepared in a manner similar to Fig. 2. The number of cores required would vary with the number of arms. The radiating sides of the box would carry half-sections of the arms on each side for one set of arms and the other set would be represented by the central arm, or instead of securing half-sections of the arms to the sides they may be located at equal distances from the centre of the box, so that the angle formed by their centre lines will be equal,

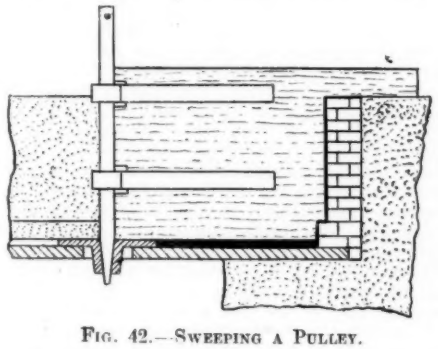


FIG. 42.—SWEEPING A PULLEY.

360 deg. divided by the total number of arms. Thus, if the pulley has six arms in each set the angle will be 30 deg. The two methods are shown in Fig. 40. With this method, the cores are made in the bottom side down and do not require turning over. Grids are introduced in each core, having staples for lifting, they can therefore be easily handled, and it is not possible to set them in wrongly if the print side is always kept down.

The formation of the mould is indicated in Fig. 41. Larger pulleys are usually made in either dry sand or loam. The former is used when a pattern is supplied. When loam is used it is customary to sweep out a cope and thus save the expense of either a wood or loam pattern and to limit the amount of tackle which would be involved in preparing such a mould above the floor. It is a good plan to prepare a pit and place a foundation plate at the bottom. The intervening space between the side of the circular hole and the finished cope should be filled with bricks and loam, the cope board being rotated about a centre spindle to give the requisite shape. Providing that the joint of the mould, representing the top of the pulley, is flush with the floor level, as shown in Fig. 42 the floor sand will offer sufficient resistance to the pressure of the metal when casting and only the cover box need be weighted. This method answers well for all large pulleys when only one or two of a definite size are required, as is frequently the case. Usually the core is prepared in sections. They may be made in dry sand or loam and both cores and mould should be blackened to give a good skin to the casting and to enable the sand to peel, so that the time occupied in fettling is reduced. With all dried moulds for pulleys it must not be forgotten that greater resistance is offered to the contracting metal than is the case with green-sand moulds, thus particular attention must be given to easing the casting shortly after the mould has been poured. Considerable assistance in this direction can be afforded in the formation of the cores. They should be just sufficiently strong to withstand the rush and pressure of the metal. Thus, by keeping the loam exterior of the core comparatively thin and filling the remaining area with ashes, it will crush under the contraction strain. The unequal rate of cooling due to the varying sectional areas in a pulley create considerable trouble with contraction. By increasing the rate of cooling of the comparatively heavy sections about the boss the liability to fracture is reduced. The use of a chill for the centre core is effectively employed for this purpose, a very slight taper need only be given, and it is knocked out after surface of the boss has been bared while it is still red hot.

It cannot be claimed in this article to have exhausted the many methods of pulley moulding. Indeed, there are so many types of driving pulleys and the ways that are adopted to manufacture them are so various that many articles would be required to describe them all. The methods that have been discussed have, however, been the result of actual experience, and the writers believe that they are the best methods for this class of work. There is certainly no class of patternmaking and moulding which lends itself more to ingenuity in devising economical practices than pulley manufacture.

The British Cast Iron Research Association.

During the month of November members have sought advice on a number of problems, the majority of which are of common interest to the industry.

In the matter of cupola practice, the questions of correct fluxing slags for desulphurising purposes, of extraordinary addition to the slags of desulphurising agents, the influence of fluxes on cupola erosion and iron losses have been dealt with.

Aid has been sought in the correct apportionment of charges of differing types of pig-iron, in the best methods for the elimination of sulphur from impure scrap, and in determining the limit of melting fatigue through repeated remelting.

Abnormal frictional and abrasive wear in gearing and piston rings, and difficulties in chilled castings have been investigated and correct mixtures and analyses suggested. Where sand mixtures or preparation of the mould have led to defects in cases submitted, examination of the sands has been made and modifications suggested to overcome such defects.

Further research work has been carried out in sand problems.

The manufacture and treatment of annealed cast irons for high-speed machining has had attention, and investigation on the reason for serious defects in certain types of large engines and machine castings are still being continued.

Further data has been accumulated for research on "shrinkage and draw hole" phenomena and towards the pig-iron grading problem.

Generally, as in the previous reports, the difficulties brought before the Director for assistance have very materially enriched the records of the Association, and have pointed the way to fresh avenues of investigation and research.

Gazette.

THE COMBINED METALS AND REINFORCED CASTING COMPANY, LIMITED, are being wound up voluntarily. Mr. M. Jenks, 6, Old Jewry, London, E.C.2, has been appointed liquidator.

ATLAS MECHANICAL COMPANY, LIMITED.—A resolution has been passed that the company be wound up voluntarily. Mr. W. H. Brown, 19a, Coleman Street, E.C., C.A., has been appointed liquidator.

MESSRS. H. ASHWORTH AND G. ASHWORTH, electrical engineers, 17, Mayville Road, Brierfield, and 33, Garrick Street, Nelson, trading under the style of H. & G. Ashworth, have dissolved partnership.

A STATEMENT of the affairs of William Parry, Limited, engineers, has been issued. The business acquired by the company was formerly carried on by Mr. W. Parry as the Dronfield Engineering Company, at Dronfield, and subsequently as William Parry & Company, Limited, at Foundry Street, Whittington Moor. The gross liabilities amount to £387, and on the contributories' account there is a deficiency of £815.

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Institution of British Foundrymen.

COVENTRY BRANCH.

Discussion on Mr. H. Docking's Paper on "Gas in the Foundry."*

THE BRANCH-PRESIDENT (Mr. E. Carey Hill) said the author had compared the use of gas for metal melting in four or five different methods. Personally, he had had experience in high-pressure gas melting, and in what was more or less the approved method of gas and air mixing. He could tell them that the method of mixing the gas and air in an incorporator before passing into the furnace resulted in a saving of 7,000 to 8,000 cub. ft. per ton of aluminium melted, as compared with the high-pressure gas, in which the gas is supplied under pressure of 12 lbs. per sq. in. and injects its own air. That was a corroboration of one point. He hoped that they would have had a little more illustration of the saving of waste gases for the heating of core stoves and ovens. The lecturer had outlined a method of heating a core oven, but an efficient method of utilising the waste gas from a suction gas plant used for metal melting—for instance, for the drying of cores—would be welcome, instead of having to use the fresh suction gas for that purpose.

Tests on Morgan Furnaces.

MR. E. PLAYER remarked that the use of gas in the foundry was by no means new. During the war his firm had an opportunity of making some very interesting tests in metal melting. A battery of three Morgan tilting furnaces, 600 lbs. capacity, employed on melting brass swarf, were tested for a period of six months' continuous service, accurate records being taken in respect of fuel consumed, labour involved, metal losses and maintenance and repairs, linings, crucibles, etc. One of the furnaces used coke fuel and one town's gas, using the ordinary Keith type burner with air supplied at 3 lbs. per sq in. pressure. On a short run the coke-fired furnace appeared to be the most economical, this being due to the fact that only the fuel cost and the metal losses were ascertainable. Over the period of not less than a week the oil furnace appeared to be the most economical, owing to lower labour costs in running the furnace. Over a period of a month or more, however, the gas furnace proved to be easily the best, the saving occurring chiefly in the largely extended life of crucible, lining, and burners, together with very low labour costs and low metal losses, these economies counteracting the rather higher fuel bill.

It is interesting to note that it was necessary to carry out protracted observation in order to ascertain definitely the best all-round type of furnace, so far as regards total costs.

Core Ovens.

All their core ovens, continued Mr. Player, had been fired for some years with town's gas at the ordinary town pressure with a separate air supply, but that they had now changed over to a gas and air mixture supply by means of mixing cores in correct proportions for perfect combustion at the burners.

In regard to core drying, this method had been adopted not so much on account of the cost of fuel as for the reason that very accurate temperature control is possible, a factor of the highest importance in drying such delicate cores as water-jacket cores for motor cylinders. He had yet to see a coke-fired oven where sufficiently accurate temperature control could be obtained. They had found by converting the coke-fired ovens to gas-fired that the loss in burnt or badly dried cores had been diminished to a negligible amount, owing to the fact that a few tests enabled maximum and minimum temperatures and times to be established, which figures were easily worked to by a man in charge.

Utilising Waste Heat.

He agreed that the utilising of waste heat from furnaces was a serious one, particularly when melting metal, as something like 50 per cent. of the heat generated was wasted in the form of hot gases. In this connection no doubt could possibly be entertained as to the value of accurately mixing the gas and air before applying it to the furnace.

* See issues dated December 8 and 15.

Before this system was adopted at their works the furnaceman dealt with the proportion of gas and air as he chose, and it was a common thing on going through the foundries to observe large flames issuing from the furnaces, representing excess gas which was going to waste, the furnaceman himself being quite unconcerned, as he did not have to pay for fuel. With the gas and air mixture the adjustment of the burner is taken out of the operator's control, as he can only open or close the cock, and consequently the only waste that can arise through carelessness on the part of the furnaceman occurs when the burners are left on after the metal has been taken out of the crucible.

MR. PLAYER remarked that a Belfast firm had put on the market a core-drying oven in which the hot products of combustion were circulated in a manner similar to that illustrated by Mr. Docking, with this difference, that whilst they brought the hot air from the heating furnace, together with the products of combustion, and circulated these in the stove, they also had a by-pass on the top of the stove which could be adjusted to allow of the escape of more or less of the hot gases, such escape taking off the steam or hot gases taken from the cores. This appeared to him to be necessary, as unless there is a definite out-flow from the stove, the cores are liable to be merely steamed instead of dried.

Pre-mixing is advantageous.

MR. F. H. HURREN, A.I.C., said he was pleased to hear the eulogy that Mr. Docking gave to the pre-mixed system, as in his works they had been using that particular system for just over seven years. From experience it could be said that it was admirable in every respect. They had used the pre-mixed system for melting aluminium, gunmetal, and core drying, and even used it for drying shanks and lighting up the cupola. It was found that this was a considerable economy over various other systems that have been tried. With regard to the burning of gas and injecting the air under pressure, it was found on a test made some years ago that the pre-mixed system gave a saving of approximately 75 per cent. on the gas consumption for the same amount of work done. The gas firing of core stoves was started about four years ago, and it was found that there was not only a great saving in fuel consumption compared with coke, but there was also a considerable saving in labour charges. The labour charges on gas-fired core stoves was practically nil. Personally he was not aware that there was any controversy at the present time as to the respective efficiencies of pit and barrel furnaces; it was quite definitely settled that the latter were the better. The crucible costs, now very low, due to the use of barrel furnaces, was previously something like £80 to £90 per month.

The Lecturer's Reply.

MR. DOCKING, in his reply, observed that there was only one point to answer, that was the question raised by Mr. Carey Hill of the drying of cores by waste heat from the furnace. No doubt there was a great deal to be said in favour of this proposition, but, unfortunately, most core ovens were a long way from the furnaces, and to carry the spent products a long distance when they were at a comparatively initial low temperature would be useless, as by the time they had conveyed these waste gases along the necessary flues to the core ovens the heat would be practically absorbed. Moreover, in using waste heat for core ovens by conducting it direct into the oven would make it almost impossible for the men to work in the ovens with any degree of comfort. If the core ovens were situated near to the furnaces, he suggested running the waste gases into a tubular furnace, where the exterior of the tubes could be heated, and the air made to pass by means of a fan or natural draught through the inside of the tubes to the core ovens. By this method no spent products could enter the ovens and the cores would be dried by a warm current of air passing through the ovens, which he considered would be an ideal method, moreover by the adoption of this method perfect regulation of temperature could be assured by the use of dampers.

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This undoubtedly was a good means of utilising the spent products from furnaces, but he believed the day was not far distant when furnaces would be so designed that almost every B.T.U. would be put to useful work in the furnace, that is, by using good insulating material to prevent radiation losses and using the spent gases for the pre-heating of the metal and the pre-heating of the gas and air before entering the furnace. Many furnaces were designed to do this, but he was sorry to say the design left much to be desired.

Burning-On and Bell-Founding.

NEWCASTLE BRANCH.

At a meeting of the Newcastle Branch of the Institution of British Foundrymen, held on November 26, in the Neville Hall, a Paper on Dry Sand Moulding was read by Mr. James Smith, of South Shields. The Branch-President, Mr. R. O. Patterson, who presided, announced at the outset that they had elected six new members—a total of 26 for the session, which was a record number.

Burning On.

MR. SMITH, in the course of his remarks, said that when any part of a casting had been broken off, such as a flange or a snug, or a blowhole had appeared, the moulder considered whether he could mend that without injuring the casting. Mending, so as to ensure success, would depend wholly upon what part of the job cast required it; the formation of the casting had also to be considered, as well as the kind of metal that was to be used; and therein lay the danger of burning or mending. It was not every casting that would stand a portion of it being brought to a melting heat without splitting in some adjacent part; the operation depended almost wholly upon the formation of the casting. Burning at the extremities of almost any shape was generally safe, but at the middle parts it was seldom a success. In his opinion mending of some jobs by burning should never be resorted to unless it could not be mended otherwise. It might be fairly questioned if a burnt casting was as good as one that had never been burnt. Assuming the mend had been properly done, and there were no symptoms of a crack on any part of the casting, it was equally as good as if no burn had taken place. For example, if the top of a propeller blade had been broken off, say from 2 ft. to 3 ft. long, properly burnt-on and well tested before leaving the foundry, then the same blade broke again, they would find that it had broken either above or below the last mend. Therefore, from carefully watching the results of mending, his impression was that the mend, when properly carried out, was equal in strength to the rest of the casting. Breakages occurred in castings of a certain structure, such as bedplates, condensers, cylinders, girders, etc., and where it was difficult to determine on what part of the casting an undue strain might take place owing to a portion of it being brought to a melting heat. Cast iron was of such a nature that it might be on the point of giving way and no one be aware of it, but in plain castings, and especially when the mend was at the extremities, he did not think that burning had any vital effect upon the other parts. When a large casting was about to be mended, it was best to put it into a cool stove the previous night, then fired well during the next day. When it was taken out of the stove a fire should at once be placed against the surface to be burnt. When it was properly burnt, no time should be lost in returning the casting back to the hot stove. By such a system the whole casting expanded gradually, and, cooling down with the stove, contracted slowly.

Some Historical Notes on Bell Casting.

Since the introduction of marine, turbine and Diesel and oil engines moulders were inclined to think that castings had reached a great height in development, but the casting of church bells by his antecedents was equally clever. The first bell was recorded as having been cast at Nola, in Campania, A.D. 400. Bede first mentioned bells, which were large ones, as being made in England about the year 670, and two centuries afterwards they were apparently common. In A.D. 870, according to the historian of Croyland, one of the abbots of that religious house gave to the church a great bell, which he named Guthlace, and afterwards six others which all rung together. Lardner said the use of bells of a small size was of great antiquity, as in the Jewish ceremonies of the tabernacle and afterwards in the Temple, bells of gold were attached to the robes of the High Priest. The largest bells in the world, according to travellers, were in China and Russia, and it was said that at Nankin there formerly hung four bells of such enormous size that although not swung, but only struck with a wooden mallet, they brought down the tower, and had long lain neglected amongst its ruins. One of those bells was about 12 ft. high, 7½ ft. in diameter, and 23 ft. in circumference. Its weight was computed at 22 tons. In St. Ivan's Church at Moscow there was a bell which weighed 57 tons. That was the largest bell known until Boris Godunoff gave to the Cathedral of that city a bell weighing 128 tons, and that was again surpassed by the bell cast at the expense of Queen Anne of Russia, and which weighed at the lowest estimate 192 tons. Its height was upwards of 21 ft., circumference near the bottom 67 ft., greatest thickness 23 in. That bell was on the ground. The local tradition was that the beam upon which it was suspended in the tower was accidentally burnt in 1737. Travellers suspect that to be a fable, but as writers continued to copy each other, the story continued to be repeated. The fact was that the bell remained in the place where it was originally cast. It never was suspended. Lardner said the Russians might as well attempt to suspend a first-class battleship and with all her guns and stores. It seemed there was a large fracture caused through a fire in the Kremlin, the flames of which caught the building erected over the pit in which the bell remained. Water was thrown on the heated metal to extinguish the fire, and caused a large fracture. Messrs. Clark and Cripps, who visited that great bell, represented it as quite a mountain of metal. It was said that the nobles threw many pieces of gold and silver into the liquid metal of which it was to be cast. The bell which weighed 57 tons was suspended in the belfry of St. Ivan. Its circumference was 40 ft. 9 in., and thickness 16½ in. where the clapper struck. When it was rung it yielded the finest and most solemn tones, which vibrated all over Moscow. Obviously it would be interesting to know how these bells were made; whether in sand or loam, and the necessary tackle. If they were made in loam, as probably they were, they would be swept up with boards. The questions naturally arise as to how they were dried, by what means the metal was melted, and the kind of fuel for its accomplishment.

Loam Sand Moulding.

Loam moulding stood distinctly apart from either green sand or dry sand. The principle of these three systems was to a certain extent identical, but the materials employed as well as the manipulation were very different. Of the three branches of moulding the loam was that in which the moulder could best show his ability, as the field was broader. That being so, it was hardly fair to say that of necessity he was a superior artisan to the sand moulder, for the sand worker, especially in green sand, had many more difficulties to contend with than the loam moulder. There was a peculiarity about moulding on which too much stress could not be laid, namely, that a piece of work could only be made once; and if it was imperfect in any essential particular it was spoiled, and could not be used for any other purpose. A commercial man might correct his correspondence, the designer might modify his plans during the progress of construction, the joiner or pattern-maker could replace a spoiled piece of wood, and so on, but in moulding, the neglect of some trifling thing might damage the whole casting, and it must be condemned. Engineers do not appreciate the moulder's art, but the reason was their lack of knowledge of its difficulties.

The lecturer answered a number of questions, and at the close was accorded a vote of thanks.

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Trade Talk.

THE UNITED STEEL COMPANIES have started dismantling their Mowbray Mine, Frizington.

GLASGOW merchants are considering a proposal for a Scottish trade exhibition in Amsterdam next year.

CONSOLIDATED METALS, LIMITED, have removed from Lancaster Chambers, Wind Street, Swansea, to Castle Buildings, Swansea.

THE INGERSOLL RAND COMPANY, LIMITED, have been appointed sole agents in the British Isles for the Swedish Sandviken drill steel.

THE MEETINGS of the London Iron and Steel Exchange on the London Metal Exchange, Whittington Avenue, will not start until January 3.

THE CUMBERLAND AND NORTH LANCASHIRE BLAST FURNACEMEN'S ASSOCIATIONS have agreed to a revision of the sliding scale which governs their wages.

THE YORKSHIRE ELECTRIC POWER COMPANY, LIMITED, have removed their head offices from Wellington Road, Dewsbury, to 36, Park Place, Leeds.

MR. S. A. JACKSON, of Thos. Firth & Sons, Limited, has been appointed manager of the electric melting department of Indian Steels, Limited, Asansol, India.

THE SMALL POWER ENGINEERING AND SCIENTIFIC EXHIBITION will take place at the Royal Horticultural Hall, Vincent Square, Westminster, S.W., on January 7.

"THE MANUFACTURE OF IRON" was the subject of a lecture to workmen by Mr. Geo. Ritchie, at the Technical Institute, Corporation Road, Middlesbrough, on December 15.

THE twenty-first annual dinner of the Glasgow and West of Scotland Association of Foremen Engineers and Draughtsmen was held in Glasgow on December 10. Lord Blythswood presided.

THE GRINDLE FUEL EQUIPMENT COMPANY has moved its offices to Harvey, Ill., and will continue its business under the same name. Whiting Corporation will manufacture all Grindle equipment.

SWAN, HUNTER & WIGHAM RICHARDSON, LIMITED, have secured the contract for two steamers for the Canadian lakes trade, one of which will be laid down at Wallsend and the other at Londonderry.

THE Wolverhampton Branch of the Birmingham Metallurgical Society met recently, when a Paper was read by Mr. L. Nettleton, entitled "Gleanings from every day practice in the heat treatment of steel."

A DISCUSSION on foundry problems, inaugurated by Mr. E. H. Brown, took place at the meeting of the Newcastle Branch of the Institution of British Foundrymen on the 10th inst. Mr. S. W. Wise presided.

THE members of the Staffordshire Iron and Steel Institute met at the Education Offices, Dudley, on December 10, when a Paper was given by Mr. F. S. Wilkinson, on "Cast Iron for Foundry Purposes."

AT a meeting of the Sheffield Association of Metallurgists and Metallurgical Chemists, held on the 13th inst., Dr. F. Rogers delivered a lecture on "The Corrosion of Metals." Mr. P. B. Henshaw (president) occupied the chair.

W. H. ALLEN, SONS & COMPANY, LIMITED, Queens Engineering Works, Bedford, have appointed Mr. H. Astbury, of Empire House, 159, Gt. Charles Street, Birmingham, as their representative for the Birmingham district.

THE MEMBERS of the Scottish Centre of the Institution of Locomotive Engineers met at the Royal Technical College, Glasgow, on Friday, to hear a paper read by Sir Henry Fowler on "Steel for Locomotive Purposes."

THE 81st Royal Agricultural Show will be held at Cambridge next year, from Tuesday, July 4, to Saturday, July 8. The 1923 show will be held at Newcastle-on-Tyne, the 1924 show at Leicester, and the 1925 show at Chester.

THE EXECUTIVE of the Amalgamated Engineering Union have advised their members to vote for the agreement on freedom of management and overtime, provisionally arrived at with the Engineering and the National Employers' Federations.

CAPTAIN STIRLING has intimated to his employés at the Montreal Iron Ore Mines, Cleator Moor, that he is prepared to open the mines for two weeks on a basis of £5 10s. The mines at present working are paying wages on a £7 basis for a period which terminated last week.

SPEAKING at Middlesbrough last week, Sir Hugh Bell, a director of Messrs. Dorman, Long & Company, Limited, said his firm had secured a contract for 60 miles of double pipe line, for the Bombay Corporation, which would require about 70,000 tons of steel plates, in weekly quantities of 500 tons.

WHITING CORPORATION, Harvey, Ill. (Chicago Suburb) has purchased a controlling interest in the Grindle Fuel Equipment Company, manufacturers of complete powdered coal plants for use in connection with malleable furnaces, annealing ovens, steam boilers, billet heating, and various other types of furnaces.

AS THE RESULT of lack of interest, and the difficulty of securing the necessary funds to continue its work, it has been decided to wind-up the British Federation of Iron, Steel, Tinplate, and Metal Merchants. Meetings will be held on January 4 and 13 to pass the necessary resolutions and to appoint Mr. G. H. Ellis, the secretary, as liquidator.

AT A MEETING of the North-Eastern Centre of the Institution of Electrical Engineers, held at the Armstrong College, Newcastle, a paper by Messrs. L. J. Steele and H. Martin on "The Cyc-Arc Process of Automatic Electric Welding" was read by Mr. Martin. Professor W. M. Thornton presided.

THE BRISTOL CHANNEL SHIP REPAIRERS' FEDERATION propose to reduce wages at the end of the year. It is suggested that day-wage men should accept a reduction of 12s. 6d. per week—4s. 2d. in January, 4s. 2d. in February, and 4s. 2d. in March. It is also proposed to abolish the 7½ per cent. bonus to pieceworkers.

SIR VINCENT L. RAVEN, chief mechanical engineer of the North Eastern Railway, read a Paper on the subject of "Railway Electrification" at the meeting of the North-East Coast Institution of Engineers and Shipbuilders at Newcastle on Friday last.

MR. J. ROSSITER HOYLE, who has been associated with Thos. Firth & Sons, Limited, for nearly 40 years, and has been a director for 28 years, has relinquished the position of joint managing director at the Norfolk Works, Sheffield. He will, however, retain his seat on the board, and will attend at the London office.

ATTENTION is being directed to the regulation which comes into force on December 31, to the effect that all goods imported into Canada which are capable of being marked, stamped, printed or labelled without injury, should be so marked in legible English or French words in a conspicuous place so as to indicate the country of origin.

THE CAPITAL EXPENDITURE for the past year of the Millom & Askam Hematite Iron Company, Limited, has chiefly been in completion of the Florence Mines equipment and in the installation of modern plant at the Redhill Limestone Quarries, Millom. The Florence Mines underground developments are progressing satisfactorily. The ore is of fine quality, and there is reason to believe that the extent of this deposit is even larger than had been supposed.

THE CONFERENCE of Joint Industrial Councils and other bodies in the electrical industry in a memorandum sent to the Government and Members of Parliament, states that it "views with great alarm proposals put forward in certain quarters to carry out the construction of certain electric generating stations and electrification of railways by placing the works in German hands, and accepting the constructions as part of the reparation payments."

SIR ALFRED MOND received, at the Ministry of Health last week, a deputation, introduced by Lord Southwark, which asked that the law in England and Wales on the rating of machinery should be put on the same basis as the law in Ireland and Scotland. Sir Alfred Mond remarked that the question as to whether machinery which was not attached to the building should be exempted from rating was complicated, and he could not make any definite statement as to what would be done.

THE DIRECTORS OF Richard Thomas & Company, Limited, announce that considerable sums have been spent during the past 12 months on the Redbourn Hill Iron & Coal Company, Limited, with a view to cheapening costs of production, and the board have in contemplation important expenditure in the development of the Sharlston Colliery in order to ensure a sufficient and cheap supply of coke to the blast furnaces. The board also contemplate important developments in the manufacture of steel.

The order handed out recently by the Canadian Pacific Railway Company to the Algoma Steel Corporation, Limited, at Sault Ste. Marie, Ont., for 32,000 tons of rails, brings the total amount of the rail orders placed by the C.P.R. this year up to 82,000 tons. A further contract for the manufacture of 20,000 tons of steel rails for the Canadian National Railways has been awarded by the Department of Railways and Canals at Ottawa to the Dominion Steel Corporation, and this will keep the plant at Sydney, N.S., busy for nearly two months.

THE DEPARTMENT OF OVERSEAS TRADE is in receipt of information from the Commercial Counsellor of His Majesty's Embassy in Tokio (Mr. E. T. Crowe, C.M.G.) regarding the forthcoming Peace Exhibition, which is to be held there from March 10 to July 31, 1922. The Commercial Counsellor states that this exhibition may prove a good opportunity for showing new British goods, and he recommends British firms to make a small exhibit. It would appear that all the space available for foreign exhibits has been over-applied for. Messrs. Arthur Buckney & Company, of Tokio, have, however, secured a special site for the erection of a British Pavilion, and intending exhibitors can obtain space therein on application to the London office of the firm at 40, Westminster Palace Gardens, Victoria Street, S.W.1.

IRON AND STEEL MARKETS.

Pig-iron.

As usual, towards the end of the year, market movements in pig-iron have a tendency to relaxed activity, and on this particular occasion the almost entire absence of demand provides little inducement to attendance on the part either of producers or consumers. Reports from all centres of the iron industry continue discouraging as to the present position and the immediately near future of the trade, no fewer than six blast furnaces having been recently blown out in Scotland, while three have been damped down, leaving only nine engaged in actual production in that district. In South Staffordshire there are as yet no signs of blast furnaces being re-started, with only three in active operation, although a slightly better demand for foundry iron is reported, Derbyshire No. 3 having first call at 97s. 6d., with Northamptonshire round about 95s. at furnace. Derbyshire forge quality is nominally 90s., and at Birmingham, apart from cold blast for which 300s. is asked, but not conceded, there is no South Staffordshire iron on the market. At Middlesbrough, the Cleveland ironmasters are still awaiting the decision of the railway managers on the question of freight rates, which it is confidently hoped will show a substantial reduction in the costs for transport of both raw materials and pig-iron, which now inflict such a heavy handicap on the trade. It is not, however, expected that an announcement on the matter will be made till after the holidays, when possibly smelters will be in a position to offer concessions in prices as a stimulus to revived demand. Business in the Cleveland market meanwhile is in very limited volume, with prices remaining at previous levels, quotations ruling as follow :—No. 1 Cleveland 105s., No. 3 Cleveland G.M.B. 100s., No. 4 foundry 95s., No. 4 forge 90s., mottled and white 85s.

Recent reductions in the East Coast hematite quotations are certainly attracting considerable attention, some fairly substantial shipments having been booked for South Wales, while export trade in this quality iron continues quiet. Quotations for East Coast remain nominally 105s. for mixed numbers, but dealings at 2s. 6d. below that price are said to have been negotiated.

Finished Iron.

Business in the finished iron sections awaits the long-expected revival of demand, and with the exception of a few marked bar firms, manufacturers are practically idle, or only very partially employed. In South Staffordshire most consumers are, as usual, at this season, engaged in stock-taking, with buying suspended until the turn of the year, while the holidays are expected to be extensively prolonged, as mills and forges in the district are badly off for work. Some of the nut and bolt concerns in the Black Country are averaging not more than 25 to 30 hours a week, and can maintain that time only with depleted staffs. The associated trades in consequence are suffering badly, with the usual result that price cutting is becoming more and more prevalent. Nut and bolt bars, for instance, which are maintained officially at £13, can be bought, it is asserted, from unassociated houses at 10s. to 20s. below that figure. Not only so, but the standard list of extras is extensively cut, and firms, who are loyal to the Association, are naturally discontented. Lancashire foundrymen are also experiencing a lean time, complaining that they are not getting their fair proportion of orders for castings, and that even if they were, these orders are very much less in quantity than they have been for a long time. The outlook is further depressed by the heavy railway rates, both on pig-iron, which has to be brought from a distance, and the castings, which may be ordered by other districts.

Steel.

Although without any visible signs of increased activity, the steel industry is not altogether destitute of encouraging symptoms of revived activity in some branches in the near future, and while the recent abandonment of the Government shipbuilding programme has had an adverse effect upon general trade, it is still hoped that in other departments there may soon be a recovery. For the present, however, the actual business passing in steel is negligible in volume, nor will these conditions undergo much change until the new year is fairly well advanced. The outstanding favourable feature in the position is the steady downward trend in prices, which has already brought quotations for home steel products almost to equitable levels with those of Continental makers, although admittedly without any margin of profit to British producers. Among the few exceptions to the general rule of idle works are steel-makers catering for the motor vehicle industry, the large number of orders for cars placed during the recent show at Olympia having much improved the demand for material essential in this branch of manufacture. The demand for open-hearth steel continues on a restricted scale, and virtually there is nothing doing in crucible qualities. Manufacturers of railway material also are only partially employed, some of the smaller companies being compelled to delay ordering until the financial outlook is clearer. Some of the heavy engineering works are slightly better employed, while the number of inquiries coming to hand is quite satisfactory considering the time of the year

Scrap.

It is extremely unlikely that any material change in the position of the scrap trade can be anticipated during the current year, business in all the chief markets continuing quiet, with buying entirely restricted to the smallest possible proportions, sufficient for urgent requirements. In South Wales, however, the steel works are using increased quantities, and should shortly come on the market for large supplies when conditions are more settled, and the future trade of the district can be gauged more accurately.

Tinplates.

In common with other iron and steel markets, business in tinplates has been quieter than for some time past, while speculative buying has practically ceased for the time being. Prices may be quoted at figures ranging from 21s. to 22s. basis for coke finish, net, f.o.t. For forward delivery 20s. 6d. is quoted generally, but transactions have been reported at 20s. 3d. to 20s. 9d. for ordinary specifications. Wasters in ICW 28 x 20 are steady at 40s., and ICW 14 x 18½ are still wanted at 20s. 3d. to 20s. 6d., f.o.t. at works. Terneplates are in a little better demand, and at figures ranging round 20s. to 20s. 3d. basis f.o.b. a moderate business is reported.

Metals.

Copper.—The near approach of the holidays has given a quieter turn to business in standard copper, the week's markets opening with a diminished demand on consumer's account. American advices, however, continue favourable, and this imparts some firmness on this side, values showing few fluctuations, and closing on Monday unchanged on balance. Refined copper showed an easier tendency, electrolytic being unchanged to 10s. lower at £74 10s. to £75 10s., with wire bars also easier at £75 to £75 10s. Closing prices :—Cash : Wednesday, £66 12s. 6d. ; Thursday, £66 10s. ; Friday, £66 15s. ; Monday, £66 15s. ; Tuesday, £66 12s. 6d. Three months : Wednesday, £67 12s. 6d. ; Thursday, £67 10s. ; Friday, £67 15s. ; Monday, £67 15s. ; Tuesday, £67 12s. 6d.

Tin.—Business in this metal in Monday's opening market was quite unaffected by week-end Eastern advices giving Singapore as sellers at £177 10s., nor by favourable American cablegrams, a heavy volume of realisation having an adverse influence on this side, leading to a substantial decline in standard tin values. The week's market opened with a setback of 30s. in three months' sales, closing on balance 40s. down for cash and 35s. three months. English ingots also showed a decline of 30s. at £171 10s. The weekly return of stocks in London warehouses was lower on the week at 5,160 tons ; Liverpool at 2,259, a decrease of 64 tons, with Swansea unchanged at 25 tons. Closing prices :—Cash : Wednesday, £170 ; Thursday, £174 10s. ; Friday, £174 10s. ; Monday, £172 10s. ; Tuesday, £171 10s. Three months : Wednesday, £171 15s. ; Thursday, £176 10s. ; Friday, £176 5s. ; Monday, £174 10s. ; Tuesday, £173 5s.

Spelter.—Demand for this metal during the past week has been well sustained chiefly on forward account, sales over the first quarter contributing the bulk of the business transacted. Near dates were advanced 5s., with forward 2s. 6d. better. Closing prices :—Wednesday, £27 5s. ; Thursday, £27 10s. ; Friday, £27 15s. ; Monday, £27 15s. ; Tuesday, £27 12s. 6d.

Lead.—Only a quiet business is reported in the lead market, December soft foreign pig being done at £25 15s. to £25 12s. 6d., but closing 2s. 6d. lower for both cash and forward positions. English closing prices :—Wednesday, £27 ; Thursday, £27 ; Friday, £27 ; Monday, £27 ; Tuesday, £27.

XUM

Company News.

Falkirk Iron Company, Limited.—Interim ordinary dividend, 5 per cent., less tax.

Howard & Bullough, Limited. — Quarterly ordinary dividend, 6d. per share, less tax.

Zinc Corporation, Limited.—Dividend, 2s. per share on preference, first half of dividend for 1921, less tax.

Birmingham Aluminium Castings (1903) Company, Limited.—Dividend, 10 per cent., free of tax, for year.

Irvine's Shipbuilding & Dry Docks Company, Limited.—Preference dividend for half-year, 8 per cent.

Minerals Separation, Limited. — Profits, £16,629; brought forward, £16,260; total, £32,889, carried to balance-sheet.

Kayser, Ellison & Company, Limited.—Interim dividend on ordinary passed; half-yearly preference dividend declared.

Allied Tin Box Makers, Limited.—Capital £2,000 in £1 shares. Secretary, E. H. Hutchinson. Registered office: Gresham Chambers, Kingsway, Cardiff.

Putney Founders, Limited.—Capital £3,000. Director and secretary: H. H. Jeffries. Registered office: 207, Putney Bridge Road, Wandsworth, S.W.15.

Aqua Electric Company, Limited.—Capital £8,000 in £1 shares. Directors: Woolf Barnato and Capt. E. F. Spencer. Secretary: J. K. Carruth. Registered office: 116, Putney Bridge Road, S.W.15.

Cleveland Bridge & Engineering Company, Limited.—Net profit, £32,917; brought forward, £4,009; ordinary dividend, 7½ per cent., making 10 per cent., tax free, for year; carry forward, £8,296.

Bull's Metal & Melloid Company, Limited.—Dividend and bonus for year, 20 per cent., free of tax; income and Corporation profits taxes, £7,000; dividend equalisation fund, £6,000; carried forward, £4,642.

Hills' Dry Docks & Engineering Company, Limited.—Profit, £8,461; brought forward, £22,647; interim dividend, 10 per cent. per annum, £6,550; final dividend, 10 per cent. per annum, £6,550; carry forward, £18,008.

Vickers, Limited.—Profit for 1920, £541,260; preference dividends for 1920, £395,985; balance, £145,275; brought forward from 1919, £846,363; at credit of profit and loss account, £991,639; no ordinary dividend.

Robson Engineering Company, Limited. — Capital £1,500 in 20 preference shares of 1s. each, and 1,499 ordinary shares £1 each. Directors: E. F. Davis and H. Grimmett. Registered office: Peerless Works, Gateshead, Durham.

Armstrong Whitworth Development Company, Limited.—Preference dividend, 6 per cent. per annum, less tax, for half-year, making 6 per cent. for year; written off formation expenses, £5,658; carried forward, £14,340; ordinary dividend, 15 per cent., free of tax.

North Lonsdale Iron & Steel Company, Limited.—Depreciation, £3,487; writing off from investments, £8,702; credit balance, £12,608; brought forward, £17,044; further dividend, 3½ per cent., making 6 per cent. (less tax) for year; carried forward, £17,653.

Millom & Askam Hematite Iron Company, Limited.—Brought forward, £12,124; interim ordinary dividend, 2 per cent.; debenture interest and redemption, £9,303; credit balance, £64,458; final ordinary dividend, 3 per cent., making 5 per cent., free of tax, for year; carried forward, £29,708.

Nantyglo & Blaina Iron Works Company, Limited.—Received from royalties and wayleaves, £15,066; from rent of land and houses, £14,329; total, £29,396; two instalments of dividend on account of arrears upon 8 per cent. preference shares paid. £25,000; depreciation of properties, £4,000.

TRADING IN THE STYLE of W. Stay & Son, Messrs. W. Stay and W. G. O. White, 129, Lower Addiscombe Road, general engineers, have dissolved partnership.

BEAVER ENGINEERING COMPANY, LIMITED.—It has been resolved that the company be wound up voluntarily, Mr. D. D. Halliday, 11, Spring Gardens, Manchester, C.A., liquidator.

MR. J. D. WORMALD, who died in London on December 10, aged 58 years, was chairman of the Australian engineering firm of Wormald Brothers, Limited, Sydney, and a brother of Sir John Wormald, one of the directors of Mather & Platt, Limited.

Personal.

MR. C. F. DENNIS has resigned his position as representative of Alexander Duckham & Company, Limited, 4, Broad Street Place, E.C.2.

SIR JAMES KEMNAL has been received by the King of Spain, and congratulated upon the rapid completion of the Spanish Babcock & Wilcox works at Bilbao.

DR. L. S. STAMP, demonstrator in Geology in the University of London, has resigned that position to become geological adviser to the Yomah Oil Company.

SIR JAMES MCKECHNIE, managing director of Vickers, Limited, has sailed for New York. Before returning to this country he will visit industrial centres in Canada.

MR. N. HUNTER, of Barclay, Curle & Company, Limited, has been appointed general manager at Swan Hunter, Wigham-Richardson & Company's shipyard, Wallsend, in succession to Mr. W. Boyd, who was recently elected managing-director of Workman, Clark & Company, Limited.

Deaths.

MR. W. P. BROWN died at Mount Gerald Larbert, on December 11. The deceased gentleman was foundry commercial manager to the Carron Company, Limited, Falkirk.

MR. P. A. WEST, of Victoria Crescent, Barnsley, died on the 9th inst. He was manager and a director of W. Arnold & Company, Limited, boiler manufacturers, of Barnsley.

THE DEATH has taken place, after a few days' illness, of Mr. James Wardlaw, managing director of the West Lothian Steam Foundry Company, and well known in the steel industry all over Scotland.

MR. OLIVER HOWL, managing director and one of the founders of the firm of Lee, Howl & Company, Limited, Tipton Engineering Works, died recently at Sedgley, near Dudley. He was 67 years of age.

MESSRS. J. W. HARGREAVES AND R. D. SYSON, electrical engineers, 104, Park Lane, Leeds, trading under the style of J. W. Hargreaves & Company, have dissolved partnership.

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